THE ECONOMIC POTENTIAL OF

GROWTH-PROMOTING AGENTS

IN BEEF

D.E. Fowler

Discussion Paper No. 84

Agricultural Economics Research Unit
Lincoln College
Canterbury
New Zealand

JUNE 1984

ISSN 0110-7720

THE AGRICULTURAL ECONOMICS RESEARCH UNIT
Lincoln College, Canterbury, N.Z.

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PREFACE

This paper presents an economic analysis of the use of growth promoting agents for increasing the rate of liveweight gain of beef cattle in New Zealand farming systems. The analysis ensures that interactions between sheep and cattle enterprises on the one farm are taken into account. This is important as increased feed demand is a consequence of higher rates of liveweight gain; therefore, the use of feed budgeting in the analysis seems most appropriate.

The paper was written by Ms D.E. Fowler, Assistant Research Economist in the Unit. A part of the paper was presented at the 1984 Conference of the New Zealand Veterinary Association, as part of a collaborative paper titled: "Action and Economics of Growth Promotants in Farm Animals", by J.J. Bass, D.E. Fowler and S.R. Davis.

P.D. Chudleigh
Director

ACKNOWLEDGEMENTS

The preparation of this Discussion Paper has depended upon the goodwill and assistance of a number of companies and private individuals. I would like to acknowledge the debt, and my gratitude to the following people and organisations:

Dr J.J. Bass, Ruakura Animal Research Centre, Hamilton.

Mr J.R. McKenzie, Animal Production Consultant, Greta Valley.

Mr D.R. McMillan, Farm Management Consultant, Rangiora

Dr A.M. Nicol, Animal Science Department, Lincoln College

Personnel of Elanco Products (NZ) & Co., Syntex Laboratories (NZ) Ltd and Wellcome (NZ) Ltd.

Staff of MAF Meat Division, Wellington.

The investigative approach followed in this paper was initially employed in the preparation of a report to Elanco Products (NZ) and Co. I would like to thank the company for their kind permission to use and further develop the procedure in this paper.

SECTION 1

INTRODUCTION

Profitability in beef farming, as in most other sectors of agriculture in New Zealand, is under pressure. Without having recourse to price fixing on world markets, farmers can only relieve the pressure by cost-reducing or income-enhancing management practices. One such practice which is widespread in most of the beef-producing nations of the world, is the administration of anabolic or growth promoting agents (GPAs) to beef cattle.

New Zealand farmers have had relatively limited opportunity to take advantage of this technique. Concern on the part of some importing nations, particularly within the EEC, regarding the possibility of harmful residues in meat and other tissues of animals treated with anabolic agents has prompted the New Zealand government to adopt a conservative attitude towards licensing anabolic hormones as GPAs. Some synthetic oestrogens derived from stilbene which have anabolic effects were permitted as veterinary remedies only, but these were banned outright in 1981. At present only one GPA (RALGRO®, distributed in New Zealand by Wellcome (NZ) Ltd) is fully licensed for use in New Zealand.

As the concern over residues has been reduced by experience, trial results and product development, acceptance of GPAs in most countries has spread. In 1984 only Italy, the Netherlands, Greece, Algeria and the Canary Isles specifically ban imports of meat from animals treated with anabolic hormones. Section 20 of the 1983 Third Country Veterinary Directive of the EEC effectively applies the same ban to all EEC member states, but it has been suggested (McKenzie, 1983) that an EEC review of GPAs currently under way could result in a wider range of the products which are currently available being approved.

The United States, which is the major purchaser of New Zealand beef, places no limitations on the production or importation of beef treated with registered GPAs. However more than half of the beef offals exported from New Zealand are destined for EEC member states. Therefore, EEC regulations pertaining to GPAs are relevant to New Zealand beef production.

Two companies have recently applied to the Ministry of Agriculture and Fisheries for the right to market GPAs under license in New Zealand. These are Elanco Products (NZ) and Co., and Syntex Laboratories (NZ) Ltd., intending distributors of COMPUDOSE® and SYNOVEX® respectively. Provisional licenses to carry out field trials have been granted, with full licensing dependent upon a satisfactory outcome of the trials, and upon the terms of any new directives which may arise from the EEC review. It therefore seems possible that a range of growth promotants will shortly be available, which may assist the New Zealand beef farmer to increase the productive capacity and profitability of his enterprise.

Many of the large number of published trial results evaluating the performance of beef animals treated with growth promotants have compared the carcase returns from treated and control animals, but these trials have most often been carried out in intensive farming situations (mainly feedlots) in which at least a portion of the total dry matter (DM) consumed is in the form of high-energy concentrates.

In a feedlot situation, feed is a variable input. In a grazing situation, the composition and availability of feed are determined primarily by climate, season, and the area and physical capability of land, as well as by management decisions. Management of the feed resource in a feedlot does not therefore require the same judgements concerning the timing of utilisation, or distribution and interactions between different classes of livestock, as on a pastoral farm. The difference between intensive management systems and the pastoral management usually practised in New Zealand is such that economic evaluations of performance in one system may have limited application to the other.

Increasing production by physiological modification of livestock, as an alternative to breeding or environmental change, is receiving increasing emphasis in New Zealand. Examples of this type of modification include the administration of growth-promoting and fertility-inducing compounds to farm animals. But the experience of some farmers, and some trial results indicate that realising the profits suggested by the distributors of these compounds, without adapting management policy to accommodate a change in productive capacity, can be elusive. A recent article in the New Zealand Farmer [1] on the wide range of income effects from use of fertility-inducing drugs in ewes is a case in point.

The extent to which growth promotants can enhance either the productive capacity or the profitability of beef grazed from weaning to slaughter, as a secondary enterprise on a New Zealand sheep/beef farm has not, to the knowledge of the author, been clearly established.

This Discussion Paper is intended for farmers and people involved in agricultural extension work. It has a two-fold purpose:

Firstly, it identifies some of the factors which interact in determining the profitability of growth promotants as a production-enhancing technique, and then tests their possible impact on a whole-farm basis.

Secondly, it examines the sensitivity of profits where growth-promoting agents are used, to changes in one parameter affected by management policy; namely, availability of feed.

It is hoped that this study will provide an illustrative example, of which the principles may be applied to other types of physiological modifier.

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1. Fecundity in Perspective. NZ Farmer Vol. 104(22) 1983. pp.110-117

SECTION 2

GROWTH PROMOTION SYSTEMS

2.1 Introduction

The use of anabolic agents to promote accelerated liveweight gain in cattle has been practiced in North America and parts of Europe for over 30 years. Their use has become more widespread with time; by 1980, almost all steers in the United States, and 25 to 30 per cent of beef animals slaughtered in the United Kingdom were finished with growth promotants. At present, very few countries do not permit their use.

Anabolic agents can be considered in four main categories:

2.1.1 Steroid hormones.

Oestrogenic (female) and androgenic (male) hormones are normally produced in the gonads and elsewhere of entire animals, and are responsible for the large differences in growth rate and rate of maturity between sexes, as well as the sexual characteristics of animals. Preston and Willis (1971) reviewed the literature on anabolic steroid hormones, and concluded that the mode of action is imperfectly understood. It is possible that either the introduction of exogenous oestrogens could lead to a compensatory increase in androgen production from the adrenal gland to restore a balance in hormone levels; or the anterior pituitary gland may be stimulated to release more growth hormone (somatotrophin).

2.1.2 Synthetic hormones.

These are analogues of endogenous steroid hormones, being similar in molecular structure but not themselves steroids. One significant member of this group is stilbene, from which various compounds such as diethylstilboestrol (DES) and hexoestrol are derived. These compounds are strongly oestrogenic and were initially administered as feed additives, although they may also be administered as an implant. As well as increasing growth rate, the compounds can have side effects on treated animals and also leave residues in meat tissues and excreta which can affect other animals and humans. Problems of this type led to the banning of DES in the United States in 1973.

A second synthetic hormone which is widely used as an anabolic agent is trenbolone acetate. This has a strongly androgenic effect, and is marketed either alone or in combination with oestrogenic hormones. Androgens such as trenbolone acetate are believed to have a direct action on protein synthesis and degradation in muscle tissue.

2.1.3 Xenobiotic compounds.

Xenobiotic hormones are derived from plants. The most widely used compound of this type is a derivative of resorcyclic acid lactone, and was first identified as the active product of a common parasitic corn mould. The compound, zearalenone, was subsequently developed as an anabolic agent and is known as zeranol. It is a weak or impeded oestrogen which is believed to act mainly through pituitary gland stimulation, by increasing production of growth hormone, prolactin and cortisol, and by decreasing production of thyroxin and insulin.

2.1.4 Other growth-promoting compounds.

Examples of other GPAs are compounds which do not directly affect the physiology of the animal, but when added to feed can improve the efficiency of utilisation of energy absorbed from the rumen. A further broad group includes antibiotics and protein sparing products.

2.2 Growth-Promoting Agents Relevant to New Zealand Beef Producers

A general commentary on growth promotion systems for sheep and cattle by J.R. McKenzie was published as a Lincoln Foundation Study Report in 1983. However this Discussion Paper is confined to the three GPAs which are presently or may shortly become available in New Zealand, and which conform to the first and third categories of steroid hormones or hormone-like substances.

2.2.1 RALGRO®.

The product is marketed in New Zealand by Wellcome (NZ) Ltd and is the only anabolic agent at present registered for use in New Zealand.

The active ingredient, zeranol, is delivered in a 36 mg dose consisting of three 12 mg pellets. The origin and mode of action of zeranol has been described earlier; in summary, it is observed to have a protein anabolic effect and to delay physiological maturity. Ralgro is most widely used in steers of all ages from suckling to finishing, but is also promoted as having weight-gain and behaviour-modifying effects in bulls, and weight gain effects in heifers. A withdrawal period of 65 days before slaughter is required.

2.2.2 COMPUDOSE®.

The product is marketed by Eli Lilly & Co. Ltd., and is currently the subject of an application by the intending New Zealand distributor Elanco Products (NZ) and Co., for licensing as a registered veterinary remedy in New Zealand. The Compudose implant consists of a silicon rubber cylinder 3.0 cm long with a solid core and a semi-permeable outer sheath. The sheath is impregnated with microcrystals of estradiol 17β, a synthetic oestrogen which is identical in molecular structure to endogenous oestrogen. The hormone diffuses across the surface of the implant at a relatively constant rate. The period over which this diffusion is sustained depends on the thickness of the impregnated rubber sheath. The most widely available implant is effective over 200 days, although a more recently developed implant will deliver a sustained amount of oestrogen over 400 days. No withdrawal period before slaughter is required in countries in which it is registered, although the implant can be easily removed. Compudose is at present promoted for use in steers only, but in November 1983 permission was granted by the Ministry of Agriculture and Fisheries for trials to be conducted at Ruakura Animal Research Centre to determine its effect on bulls as well as steers.

2.2.3 SYNOVEX-S®.

This product is the subject of an application by Syntex Laboratories (NZ) Ltd for registration as a veterinary remedy in New Zealand. It combines 20 mg oestradiol 17 β benzoate and 200 mg progesterone delivered in eight small pellets per dose, and is specifically intended for use in steers. The combination of hormones is intended to promote weight gain while minimising effects on sexual characteristics of the animal. Syntex has also applied for registration of Synovex-H, a similar product which combines 20 mg oestradiol 17β benzoate with 200 mg testosterone for use with heifers. A new product for young calves (Synovex-C) is due for registration in the United States in 1984. There is no withdrawal period before slaughter required in countries where Synovex is registered for use.

2.3 Method of Administration

Initially, growth promotants were administered as a premixed additive to feedstuffs. Lack of real control over the quantity ingested by individual animals, and the possibility of misuse of feedstuffs were major problems. It was also an inappropriate technique where grazing animals were concerned. Anabolic agents may now be delivered by implanting as a slug or pellet either at the base of the ear (Ralgro, Synovex) or subcutaneously in the ear itself (Compudose). The hormone dissolves from the pellet and is absorbed by the animal. Diffusion rate is primarily a function of the surface area of the pellet, and can be expected to decrease with time as the pellet reduces in size. Trials summarised by Preston and Willis (1971) found that growth response to hormones delivered in pellets declined after 112 days, suggesting that reimplantation at 70 to 100 days is necessary if accelerated liveweight gain (LWG) is to be sustained over longer periods.

Because the surface area of the cylinder remains constant, the silicon rubber delivery system used in Compudose allows more precise administration over longer periods of 200 or 400 days. Where these implants are used over a finishing period only, there is normally no requirement to reimplant, with implied saved handling costs. However some early trials with silicon rubber implants (Nicol, 1982; Mathison and Stobbs, 1983) reported losses of between 4.5 and 16 per cent of implants which would necessitate reimplanting; checking after four weeks is recommended by the manufacturer.

While the weight gain advantage is usually considered to be permanent, there is evidence in some trials (Scott, 1978; Nicol, 1982) that if animals are retained much longer than the recommended implant interval, performance may fall below that of untreated animals so that overall returns are reduced. Therefore, the timing of administration of anabolic agents is dependent to a considerable extent upon the anticipated sale date.

2.4 Effects of GPAs on Livestock Performance

Growth-promoting agents can affect livestock performance in several ways; through accelerated LWG, improved FCE, and changes in carcase composition and behaviour. These effects have been studied under a variety of conditions. Some trial results give smaller LWG responses for grazed than for concentrate-fed cattle, but very high response rates have been achieved under grazing as well as in feedlots. As the level of nutrition is reduced towards maintenance, changes in the production of growth hormones occur which may over-ride the effect of an implant; some results have indicated (e.g. Sammon, 1980) that GPAs will not increase LWG where cattle are grazed on pasture that will not support growth rates at a reasonable level. Some research findings for the three products included in this paper are discussed below:

2.4.1 Liveweight gain response.

(i) RALGRO

A large number of trials have been carried out using Ralgro on steers. Liveweight gain responses have been consistently recorded, but the magnitude of response varies considerably between trials. Trials under grazing or intensive fattening systems reviewed by Scott (1978) demonstrate that administration of Ralgro to steers can result in increased LWG of between 6 and 28 per cent. Results of on-farm trials in New Zealand, some of which were monitored by MAF or local veterinarians, have been used in promotional material and gave LWG responses to repeated implants over 199, 203 and 208 days of 10.3, 13.2 and 11.8 per cent respectively.

Ralgro-implanted bulls and heifers have yielded variable results. Statistically significant LWG responses were not always observed, and where they did occur have generally been lower than for steers.

(ii) COMPUDOSE

Various trials comparing the performance of Compudose-implanted and non-implanted steers have been carried out in the United States and elsewhere (e.g. Mathison and Stobbs, 1983; Turner et al., 1981; Nicol, 1982; Lindsey, 1983). These trials have indicated statistically significant ($P < 0.05$ or better) increases in rate of LWG in implanted animals, ranging from 5.9 to 27.0 per cent. Most of the trials have been carried out in intensive or semi-intensive farming situations in which at least a portion of the total dry matter (DM) intake is in the form of concentrates. However Nicol (op. cit.) carried out a trial on 24 steers under grazing which showed a LWG response rate of 27.0 per cent, suggesting that large gains can be achieved both with grazed and concentrate-fed animals. There are no trial data available at present regarding the effect of Compudose on bulls.

(iii) SYNOVEX-S

The LWG response of steers to Synovex-S shows a similar range to those reported for Compudose and Ralgro. A number of trials carried out by the Livestock Branch of the British Columbia Ministry of Agriculture, and used in promotional material gave LWG responses of between 3.6 and 27.8 per cent under grazing. Other trial results, for example those published by Embry and Gates (1976), Everitt (1963), Rumsey (1982) and Kahl et al. (1978), carried out under grazing or combined grazing/grain feeding, gave LWG responses of 12.6, 33.0, 22.7 and 18.6 per cent respectively.

2.4.2 Feed conversion efficiency.

Improved FCE after implanting has been observed by some workers. Not all trials have measured feed intake as well as LWG response to implants, and nearly all those which did so were carried out in a feedlot situation. There is therefore little data regarding changes in FCE on all-grass diets. Some researchers (e.g. Rumsey, 1982; Mathison and Stobbs, 1983; Heitzmann, 1981; Lindsey, 1983) who have compared DM requirements of implanted and non-implanted steers have recorded an improvement in FCE of between 4.9 and 10.1 per cent. The response is variable however; Turner et al. (1981) and others found no statistically significant difference, although these findings represent only a minority of results.

Whether the reported improvements in FCE can be attributed entirely to the increased efficiency inherent in faster rates of liveweight gain, or whether administered oestrogens can affect FCE via some other mechanism, has not been addressed explicitly in most of these trials. It can be demonstrated using MAF feed budgeting data that there is an improvement in FCE of approximately 4 per cent for a 12 per cent increase in rate of LWG, although this varies with rate of gain; suggesting that where improvements in FCE of more than 4% are reported, some of the improvement is indeed caused by implant effects unrelated to rates of gain. Preston (1975) noted in a review of biological responses to oestrogen additives in beef and lamb production that enhanced protein utilisation and deposition appears to be a major effect of oestrogenic implants. Therefore improved FCE due to implanting may combine both these effects.

2.4.3 Carcase composition.

By delaying physiological maturity, oestrogenic implants prolong the juvenile growth phase during which nutrient intake is directed more into bone and muscle growth than into fat deposition. The effect on carcase composition of the three types of implant included in this study on carcase composition have been measured and reported in a number of trials (e.g. Everitt and Jury, 1963; Scott, 1978; Mathison and Stobbs, 1983), but differences are not consistent, and are rarely large. Dressing out percentage (DO%), fat depth, rib-eye muscle area and skeletal formation have been measured and in some cases significant differences due to treatment have been detected.

A majority of papers reviewed by Scott (1978) or discussed by others (e.g. Willemart, 1981; Jones, 1982; Gregory, 1983) indicated that DO% is usually not affected by implanting. Some increases in DO% were noted (Mathison and Stobbs (1983) found a significant ($P < 0.05$) increase of 1.2 percentage points); and one trial by Alder et al. in Scott's review gave a 0.9 per cent reduction.

Dressing percentage is also affected by higher liveweights; McKenzie (unpubl., 1983) suggests that in the 200 to 300 kg carcase weight range there is an increase in DO% of 0.03% per kilogram increase in carcase weight.

Generally, fatness of the carcase was reduced, and the percentage of saleable meat somewhat higher than for non-implanted animals.

2.4.4 Behaviour.

Non-treated bulls generally achieve rates of LWG 10 to 15 per cent higher than steers, with feed conversion efficiency (FCE) greater by approximately 10 per cent. Bulls have generally shown lower and more variable LWG responses to implanting than steers. Behaviour-modifying effects of varying duration have also been noted in some trials with bulls (e.g. McKenzie, 1983; Bass, 1984; reviewed by Scott, 1978) which imply an economic benefit in terms of management cost.

SECTION 3

PROBLEM DEFINITION AND METHOD OF APPROACH

3.1 Introduction

The discussion of trial results in Section 2 indicates that, for the three growth-promotants under consideration, there is no consistent evidence to suggest that the liveweight and feed conversion responses will differ markedly between the types of implant. Where the economic benefits from implanting were estimated in the papers surveyed, this was usually confined to per-head returns net of the cost of the implant. Returns were calculated either by multiplying differences in carcase or live weights by a per kg price, or by comparing gross returns to carcases after grading.

The contribution which growth implants can make to profitability has other dimensions, however. As well as having the potential to increase returns on the carcase, implants can, by allowing target liveweights to be achieved more quickly, reduce finishing time and hence production costs, including interest payable on working capital. Faster rates of liveweight gain improve FCE, because a lower proportion of total energy intake is used for maintenance. Where improvements in FCE due to other implant effects are achieved, there may be further savings in feed cost per kilogram of carcase weight. These considerations are highly visible and relatively easy to measure in an intensive finishing operation, and are an important component of overall profitability, but do not appear to have been included in most existing economic analyses.

Where beef animals are reared and finished under grazing, effects on profitability related to changed DM demand are less easy both to achieve and to measure. Pasture is a relatively inflexible feed source; although it can be manipulated to some extent by an appropriate fertiliser regime, provision of irrigation or shelter, or by conserving as hay or silage, the resource is principally determined by climate, soil type and season.

A further relevant factor in New Zealand which can affect the profitability of growth promotants is the association of a grass-based beef rearing or finishing enterprise with other livestock enterprises on one farm. The Meat and Wool Boards' Economic Service Sheep and Beef Farm Surveys indicate that the typical beef rearing or finishing operation in New Zealand is a secondary enterprise on a sheep farm. Management decisions relating to the beef enterprise are therefore likely to have impacts on other enterprises on the same farm. Where feed is a relatively fixed resource, there is therefore an opportunity cost associated with the decision to use anabolic agents on beef animals, as well as the direct or indirect costs and benefits discussed in the preceding paragraphs. The impact which such a decision can have on sheep breeding or finishing, or on other cattle or other livestock classes has, to the knowledge of the author, never been considered in assessing the likely benefits from implants.

In common with other "physiological" means of manipulating the productive capacity of livestock, the profitability of growth promotants depends on positive management to optimise the conditions for taking advantage of higher liveweight gain potential. Traditionally, beef cattle are used to take advantage of surplus feed in spring and early summer, but depending on the management goals of the farmer, are not necessarily given priority for available feed from December onwards when feed may be short. When feed is limiting, managing pastures to optimise the LWG response to a growth-promotant must affect the availability of feed for other livestock classes.

In the absence of trial data specifically aimed at defining the possible consequences to the whole farm of the use of growth promotants, and in view of the increasing use of physiological modifiers in general with livestock, it was considered timely to carry out a theoretical exercise which it is hoped will provide a basis for discussion, and possibly field research in this area.

3.2 Selection of Measurement Method

One means of estimating the effect of anabolic agents is to carry out a partial feed budget for a representative sheep/beef farm, using rates of LWG which lie within the range of trial results for all three products. If the improvement in FCE does not exactly compensate for increased intake, the difference in DM requirements for implanted and non-implanted animals could affect the amount available to other classes of livestock at times when feed is in short supply, and thus affect livestock performance. Without introducing supplementary feed, the farm manager must therefore accept some difference in rates of LWG in other stock, or difference in lambing performance due to reduced amounts of flushing feed, or a different stocking rate.

For the purpose of this exercise, the effect of reduced flushing feed on lambing performance was considered to be too diffuse a measure, and too much influenced by other management and climate-related factors to be of value. Changes in stocking rate can introduce distortion from transaction costs and seasonal variations in livestock prices which also could obscure the effect to be measured.

Therefore, a feed budgeting approach which measures the value of changes in DM availability to the rest of the farm by estimating changes in the rate of LWG of lambs was adopted.

3.3 Limitations of the Method

The limitations of feed budgeting as a means of testing management impacts are recognised. The range of possible effects is complex and is not easily accounted for in a partial model; in particular, complementary pasture utilisation between beef and sheep, and differing levels of utilisation between livestock classes are not explicitly included in the budget. Neither can a feed budget capture changes in management and overhead costs. To enable comparisons to be made, a number of simplifying assumptions were made which attempt to reflect the reality of farm management. The accuracy of the calculations is dependent upon the DM requirement data upon which they are based.

Nonetheless it is considered that this approach will demonstrate effects which have apparently been excluded from other studies.

3.4 The Partial Feed Budget

3.4.1 The representative farm.

To place the pattern of DM availability in context, a "representative" farm in North Canterbury was defined. Advice regarding stocking policy and pasture production was given by Mr D.R. McMillan, a farm management consultant in the region.

The farm consists of 330 effective hectares of flat and lightly rolling land, producing 6.5 tonnes of DM/ha/yr to support a stocking rate of 10.5 s.u./ha. The farm is managed to produce lambs for export and prime 20 month beef. It is stocked with 2400 breeding ewes, 670 hoggets including 480 replacements, and 150 weaner steers. A 95 per cent lambing is achieved and lambs are drafted off from January onwards. No breeding cattle are kept; all beef animals are bought in as weaners at the beginning of April. No crops are grown but 4,500 bales of hay are cut in December as a winter feed supplement; no other conserved feed is used. DM production and requirements are shown in Figure 1. It can be seen that the property dries off in late summer and that feed supply is in moderate deficit from January to July. August is the month of greatest deficit, with barely 300 kg DM/ha in saved feed and pasture available at the month's end.

On this country, average daily growth rates over a full year of 0.67 kg/steer/day are readily attainable at the farm's current stocking rate. Twenty-month steers usually achieve 430 kg liveweight by sale date near the end of March. Lambs can be expected to gain 200 g/lamb/day from weaning onwards.

3.4.2 Management strategies.

Two beef management strategies were examined using the budget.

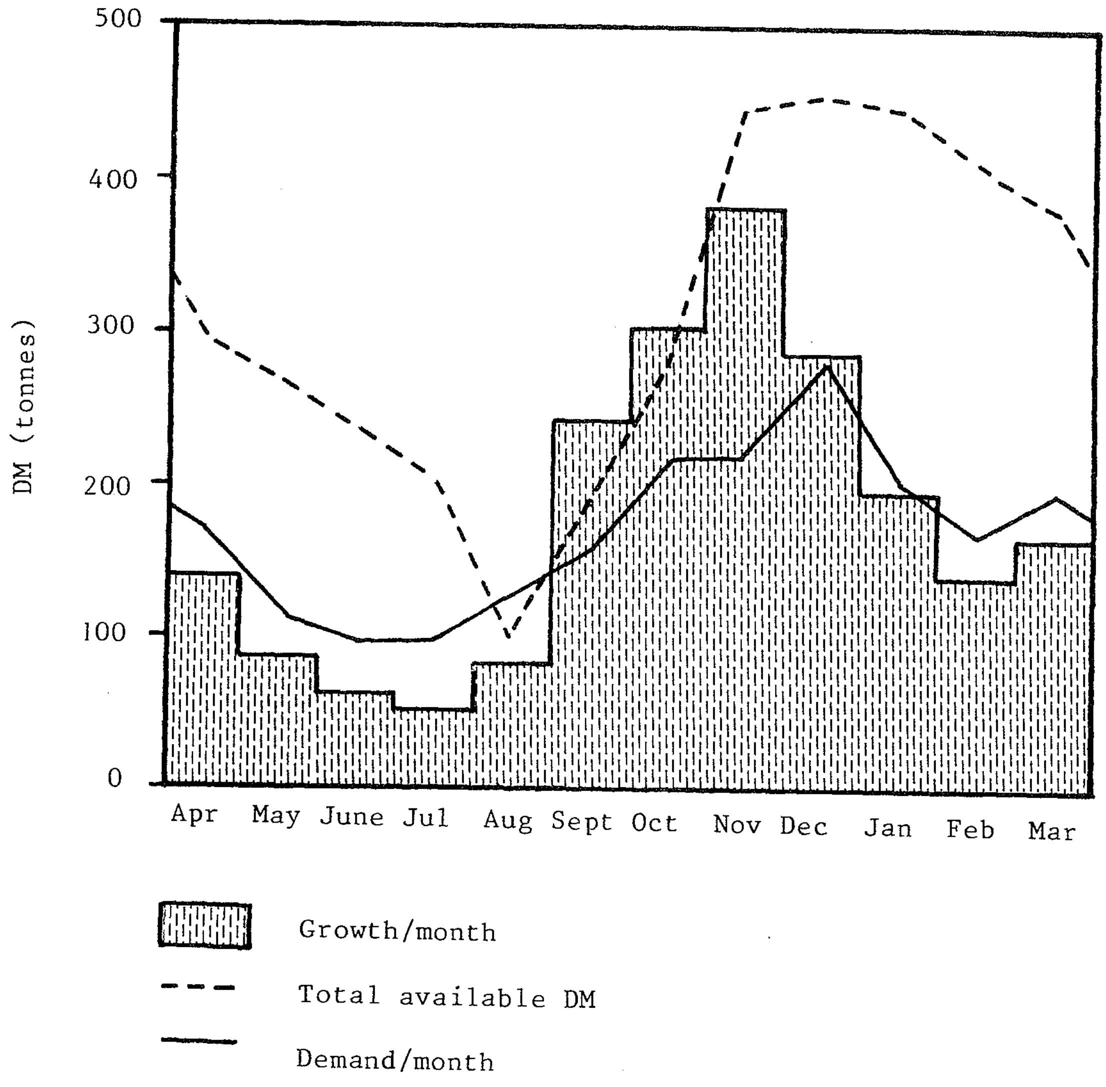
1. The animals are sold at a target sale date of 20 March of the year following purchase, at approximately 20 months of age.

2. The animals are drafted and sold as they achieve a target liveweight of 432.5 kg.

Each strategy was tested at five levels of LWG response, namely 10, 12, 14, 16 and 18 per cent; and under five sets of conditions. To demonstrate the procedure, a 12 per cent LWG response rate was selected. Net benefits for the remaining four response rates were derived in the same manner but are presented in summary form only.

FIGURE 1

DM Supply and Usage



The options described allow calculation of the likely distribution of costs and benefits if the set of conditions ascribed to that option should exist. Options A to C consider implanted or non-implanted steers. However the main reason for castrating bull calves is to avoid the management problems caused by sex-related behaviour such as aggressiveness, bulling and riding activity, and implanting steers is a means of restoring the LWG thus foregone. If behaviour-modifying effects on bulls are achievable and sustainable using implants, then substitution of implanted bulls for steers, even with no expectation of a LWG response, is a valid option for farmers to consider. Options D and E therefore consider implanted bulls. Non-implanted bulls are not included as an option. Apart from the direct cost of implanting, performance data would be identical to those in option D.

The five options are outlined below:

A. Non-implanted steers achieving an average daily LWG over one year of 0.67 kg/day;

B. Steers implanted on 1 September; thereafter achieving a 12 per cent increase in daily LWG over A. FCE is improved by approximately 4 per cent but this is entirely due to accelerated LWG;

C. Steers implanted on 1 September; thereafter achieving the same LWG as B. FCE is also improved by other implant effects, giving a total improvement over A of approximately 8 per cent;

D. Bulls implanted on 1 September, with no sustained LWG or FCE response over non-implanted bulls, but with modified behaviour;

E. Bulls implanted on 1 September, thereafter achieving a 5 per cent sustained LWG response over non-implanted bulls, with modified behaviour but no improvement in FCE other than that attributable to accelerated LWG.

Daily DM requirements were calculated by adjusting the DM requirements set out in the MAF Advisory Services Division publication "Feed Budgeting", to account for differences in FCE. Appendix 1 gives daily LWG and DM requirements for the six options on a month-by-month basis.

From September through December, any increased appetite is accommodated by surplus feed. Where feed is limiting, the management policy followed in this analysis is that stock numbers will not change, but steers will receive priority for feed. This will be allowed for by varying the daily DM allowance for part of the lamb flock by 0.5 kg DM/day/lamb up to 31 December, representing a change in the rate of lamb LWG of 100 gm/day/lamb. The procedure followed for estimating these "lamb-equivalents" and their carcase value is set out in Appendix 2. From 1 January onwards, pasture is likely to be drier and stalkier, with less metabolisable energy than the mixed-length leafy sward upon which the earlier DM allowance is based. Therefore the change in daily DM is adjusted upwards by 20 per cent to 0.6 kg/day/lamb from that date onwards, giving metabolisable energy approximately equivalent to that in a mixed-length leafy sward.

No attempt was made with either management strategy to estimate the saved cost of castration, or the value of decreased fence and pasture maintenance due to modified behaviour in implanted bulls. The per capita cost of fencing and pasture renewal is too strongly dependent on mob size, the significance of beef over the whole farm enterprise, and differences in livestock management policies for an estimated per capita figure to be feasible for this analysis; however the existence of such costs should be acknowledged. It has been suggested by one animal production consultant (J.R. McKenzie, pers. comm.) that this could be as high as $10 per head.

3.4.3 Simplifying assumptions.

The following assumptions were made:

1. Weaners are bought in at the beginning of April and carried over the winter.

2. All animals receive the same allowance of DM/day from purchase until the end of August.

3. All steers are assumed to weigh 200 kg at purchase and to have achieved 266 kg by the end of August.

4. All bulls are assumed to weigh 220 kg at purchase, and to have achieved 294 kg by the end of August.

5. Non-implanted bulls have a 12 per cent LWG advantage and 10 per cent improvement in FCE over non-implanted steers.

6. All animals are implanted at 12 months of age on 1 September. The 200-day duration of one Compudose implant is deemed equivalent to one implant of Ralgro or Synovex-S at commencement, to be followed by a second implant in early December. Five per cent of implants are assumed to be lost and require reimplanting; the implant cost is increased by a like amount.

7. Feed becomes a limiting factor from 1 January until sale date.

SECTION 4

RESULTS AND DISCUSSION

4.1 Introduction

The outcomes for each strategy and option at the 12 percent LWG response rate are summarised in Tables 1 and 3. These tables compare implanted steers and bulls to non-implanted steers, for differences in average daily LWG, variations in lamb LWG and distribution of benefits. Net benefits and opportunity costs for the two implanted-steer options at five rates of LWG response are presented in Table 2 and Figure 2 for Strategy 1, and Table 4 and Figure 3 for Strategy 2. Tables 5 and 6, and Figure 4, consider the benefits for both strategies at the 12 per cent LWG response rate where feed availability is varying. The ratio of benefits to costs is examined for both strategies and at various LWG response rates in Figures 5 and 6, and Table 7.

Supporting data are presented in Appendices 1 to 3.

4.2 The Feed Budget: Strategy One

It can be calculated from Table 1 that the total DM requirements for the implanted options increase by 7.5, 3.4, 7.0 and 9.5 per cent respectively. This is reflected in the average daily DM (ADDM) required. The difference in ADDM forms the basis for calculating the opportunity cost; in this exercise, the lamb LWG foregone. However, it should be noted that it is an average only; the difference in daily DM approximately doubles over the implant period and is highest during the summer when feed is limiting. Therefore the values of lamb LWG foregone are likely to be understated.

The improvement in FCE of 4 per cent between options A and B is inherent in a faster rate of LWG with proportionally less total DM required for maintenance. The improvement between options A and C also assumes an approximate gain of 4 per cent due to implant-induced changes other than LWG, giving an overall improvement in FCE of 7.8 per cent. FCE for implanted bulls in option D which is the same as for non-implanted bulls, cannot be directly compared to option A in Table 1 because of the difference in initial liveweight; however when weights are standardised the overall difference equals the 10 per cent improvement in FCE which was discussed in Section 3. A further 3 per cent improvement between options D and E is attributable to accelerated LWG with no other implant-induced effects.

Dressing out percentage (DO%) is influenced by a number of factors including liveweight. For this exercise an increase of 0.015 per cent per kilogram increase in live weight was adopted. The effect of DO% on carcase weight and hence returns is considerable, and reinforces the economic advantage to be obtained in faster rates of LWG, particularly when carcase weights are lifted into a higher weight range within a

TABLE 1

STRATEGY ONE : Sale at 20 Months

First Implant 1 September
12% LWG Response Rate

	A	B	C	D	E
	Steer No Implant	Steer Implanted 12% LWG Response 4% FCE Response	Steer Implanted 12% LWG Response 8% FCE Response	Bull Implanted No LWG Response Behaviour Modified	Bull Implanted 5% LWG Response Behaviour Modified
Liveweight at 1/9 (kg)	266	266	266	294	294
Liveweight at 20/3 (kg)	432.48	452.43	542.43	480.40	490.59
LWG 1/9 to 20/3 (kg)	166.13	186.08	186.08	186.08	196.27
DM required 1/9 to 20/3 (kg)	1,540	1,655	1,592	1,648	1,687
Av. DDM 1/9 to 20/3 (kg)	7.70	8.28	7.96	8.24	8.43
Difference over A (kg)	—	0.58	0.26	0.54	0.73
Conversion Rate DM:LWG 1/9 to 20/3	9.27:1	8.90:1	8.55:1	8.86:1	8.59:1
DO %	51.0	51.3	51.3	51.7	51.9
Carcase Weight (kg)	220.56	232.10	232.10	248.37	254.62
Schedule Price ($/kg)	1.601[a]	1.601[a]	1.601[a]	1.618[b]	1.618[b]
Gross Income ($/head)	353.12	371.59	371.59	401.86	411.98
Average Implant Cost ($)	—	4.42	4.42	4.42	4.42
Lamb LWG foregone if feed limiting 1/1 to 20/3 ($)	—	4.76	2.14	4.43	5.99
Income Net of Implant Effects ($/head)	353.12	362.41	365.03	393.01	401.57
Benefit over A ($)	—	9.29	11.91	39.89	48.45

a Weighted average schedule price for P1 steer, 220–245 kg carcase weight, net of butter levy, for year ending 30 September 1983. Source: NZ Meat and Wool Boards' Economic Service.

b Weighted average schedule price for M bull, 245–270 kg carcase weight net of buffer levy, for year ending 30 September 1983. Source: NZ Meat and Wool Boards' Economic Service.

price schedule grade.

All schedule prices used were New Zealand weighted average prices on-farm for the 1982-83 year, including supplementary payments but net of buffer levies.

The schedule prices are assumed for this exercise to apply to a single animal. However if the carcase weights calculated were to represent the mean for a mob of animals, then the distribution of weights about the mean would affect the average price per kilogram. This is particularly so in option A, where the carcase weight only just falls into the weight range of 220-245 kg for the quoted schedule price. An average price for a mob of steers with a mean carcase weight of 220.56 kg and normal distribution would be lower by approximately 4.0 cents per kilogram.

Approximately half of the 27.81 kg difference in carcase weights between options A and D is attributable to a lower rate of LWG in option A due to castration. The balance is due to differing initial weights. The effect of this difference is enlarged by a schedule price difference between weight ranges which favours the heavier weights achieved by the implanted-bull options, giving a total difference in gross incomes per head of $48.74. However bull beef in 1983 received a lower schedule price per kilogram than steer beef in the same weight range. Weighted average schedule prices for steer, bull and manufacturing cow beef from 1975 to 1983 are given in Appendix 3, and show that prices for bull beef were higher than for steer beef from 1976 to 1980, and lower from 1980-81 onwards. Variations of this nature can cause the magnitude of benefits to expand or contract slightly over time.

Differences in gross income between non-implanted steers (A) and implanted steers and bulls (B to E) were $18.47, $18.47, $48.74 and $58.86 respectively. The full cost of implanting, including direct and opportunity cost, is respectively $9.18, $6.56, $8.85 and $10.41, giving net benefits due to implanting of $9.29 and $11.91 for the two steer options, or $39.89 and $48.45 where implanted bulls are compared to the non-implanted steer.

The direct cost of implanting, clearly, is the average price of the implant itself. This is based on $3.50 (estimate only) for a single Compudose implant and 2 Ralgro implants at $2.495 each. No price was available for Synovex-S. The cost was inflated by 5 per cent to allow for reimplantation due to losses, or to administration errors. It is assumed that implanting will be carried out at a time when the animals are yarded for other purposes such as drenching, and therefore there is no additional management cost involved. The opportunity cost, valued in lamb LWG foregone, of $4.76, $2.14, $4.43 and $5.99 respectively, effectively doubles the overall cost of implanting in all cases except option C, in which the total cost is increased by approximately half. Because implanting bulls is assumed to avoid behaviour-related management costs, no increase in management cost for bulls is necessary for this comparison.

Figure 2 demonstrates the relationship between LWG response rate, gross income and cost of implanting for option B. The data from which this figure is derived are set out in Table 2, showing the benefits and costs which may accrue to the implanted-steer options as the LWG response to implanting increases. It can be seen that an increase of 8 percentage points in LWG response could generate an additional $9.26 or 136 per cent increase in benefits for option B, or $9.42 or 101 per

TABLE 2

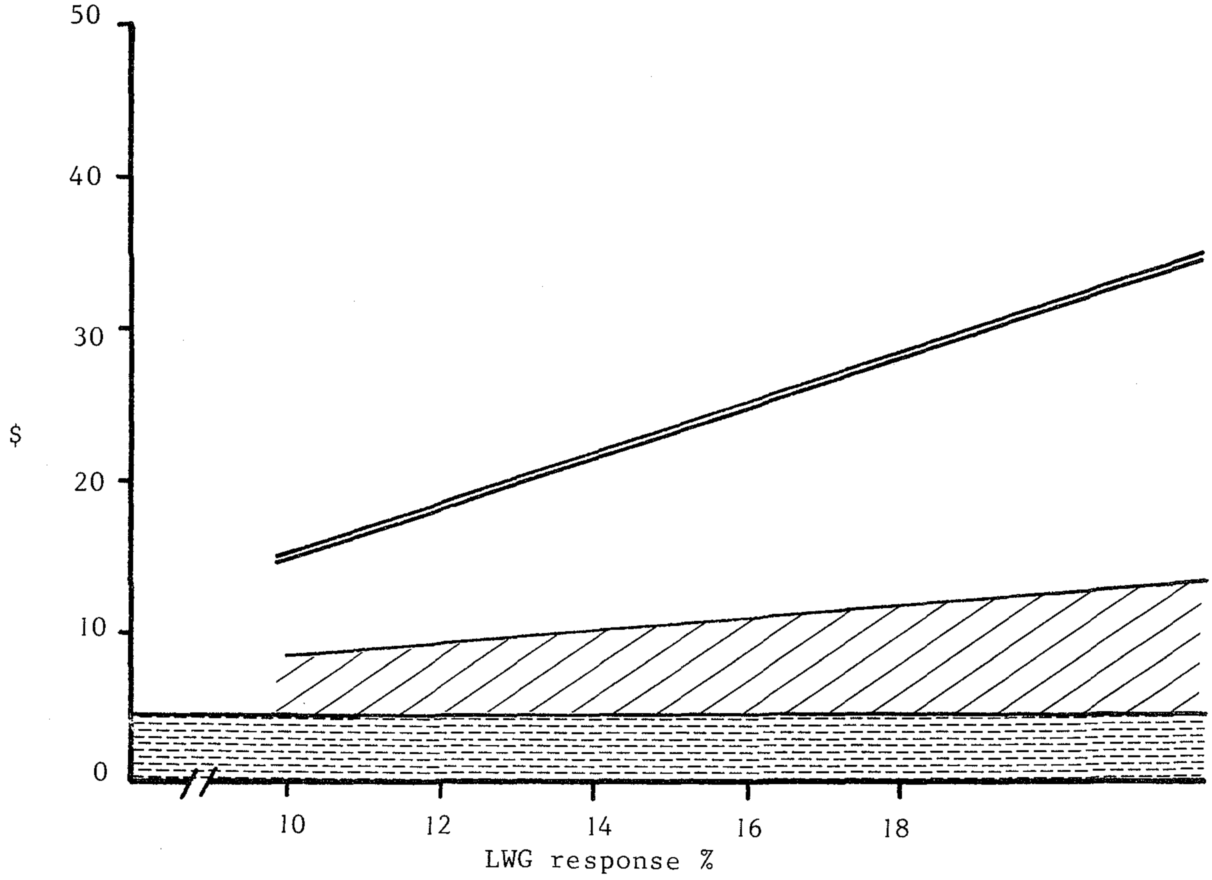
STRATEGY ONE: Sale at 20 Months.
Costs and Benefits for Implanted-Steer Options
LWG Response Rates Varied; Feed Conditions Constant

LWG Response Rate (%):	10	12	14	16	18
OPTION B:					
Costs:	$	$	$	$	$
Implant	4.42	4.42	4.42	4.42	4.42
Lamb LWG foregone	3.78	4.76	5.74	6.57	7.39
Benefits:					
Increase in carcase value	15.00	18.47	22.26	24.68	27.87
Net Benefit due to Implant	6.80	9.29	12.10	13.69	16.06
OPTION C:					
Costs:					
Implant	4.42	4.42	4.42	4.42	4.42
Lamb LWG foregone	1.23	2.14	3.12	3.86	4.68
Benefits:					
Increase in carcase value	15.00	18.47	22.26	24.68	27.87
Net Benefit due to Implant	9.35	11.91	14.73	16.40	18.77

cent increase in benefits for option C. The opportunity costs associated with these levels of LWG response also increase, contributing an increasing proportion to the total cost of implanting,

FIGURE 2

STRATEGY 1, OPTION B: Changes in costs and benefits at various levels of LWG response



Average implant cost

Opportunity cost (lamb LWG foregone)

Net benefit due to implant

Gross benefit over non-implanted steer

but these increases are exceeded by the increase in benefits, in a ratio of 2.6:1 and 2.7:1 for options B and C respectively. Therefore, while opportunity costs are likely to be higher with large LWG responses to implanting, their effect on the magnitude of benefits will be less than at lower levels of response.

4.3 The Feed Budget: Strategy Two

Strategy 2, aimed at selling animals at a target liveweight, is summarised in Table 3. DM requirements were calculated in the same manner as for Strategy 1. The differences in ADDM form the basis for determining opportunity cost, which is somewhat more complex under this Strategy. From 1 January to sale date there is a cost in lamb LWG foregone as in Strategy 1; however the duration of the finishing period after implantation is substantially shortened for all implanted options over non-implanted steers. The grazing saved for options B to E amounts to 24, 24, 62 and 71 days respectively, releasing 7.7 kg DM per day. This is assumed to be used to increase LWG in lambs by 100 gm/lamb/day, following the procedure set out in Appendix 2.

The shorter time taken to reach target liveweight also represents a reduction in overhead costs; income received earlier improves liquidity and avoids interest charges on working capital. In this instance an overdraft interest rate of 13.25 per cent was chosen, on the advice of a major trading bank.

A further component of overall opportunity cost for options D and E concerns the schedule price for bull beef, which in 1982-83 was slightly lower for manufacturing bull than for P1 steer for the same carcase weight range. The on-farm price differential amounts to 1.3 cents per kilogram foregone, or $2.86 per head for a 220.5 kg carcase.

The effect on profitability of these components varies considerably. The value of lamb LWG foregone from 1 January to respective sale dates is slight or negligible for the four implanted options at $2.41, $0.62, $0.63 and $0.25. The largest contribution to profitability stems from the duration of the finishing period. The release of DM in the late summer allows additional growth in lambs valued at $19.21, $19.21, $49.63 and $56.83. The second component of profitability lies with the overdraft interest which can be avoided, of $3.08, $3.08, $7.88 and $9.03. In combination the total net benefits realisable from implanting at a 12 per cent LWG response rate are $15.46 and $17.25 for the two implanted-steer options, or $49.59 and $58.33 where implanted bulls are compared to non-implanted steers. These benefits are greater by $6.17, $5.34, $9.70 and $9.88 than their counterparts in Strategy 1.

The effect of these costs and benefits on overall profitability is demonstrated in Figure 3 for option B, at varying levels of LWG response. The data are presented in Table 4. It can be seen that the lamb LWG foregone remains an insignificant cost, declining further in importance as the LWG response rate increases.

The key to profitability with this strategy lies in the use to which the saved late-summer grazing is put. For this exercise,

TABLE 3

STRATEGY TWO : Sale at 432.5 kg Liveweight

First Implant 1 September
12% LWG Response Rate

	A	B	C	D	E
	Steer No Implant	Steer Implanted 12% LWG Response 4% FCE Response	Steer Implanted 12% LWG Response 8% FCE Response	Bull Implanted No LWG Response Behaviour Modified	Bull Implanted 5% LWG Response Behaviour Modified
Liveweight at 1/9 (kg)	266	266	266	294	294
Days to Target Liveweight	200	176	176	138	129
Sale Date	20/3	23/2	23/2	16/1	7/1
DM Required 1/9 to Sale (kg)	1,540	1,431	1,375	1,115	1,038
Average DDM 1/9 to Sale (kg)	7.70	8.13	7.81	8.08	8.05
Difference over A (kg)	—	0.43	0.11	0.38	0.35
Days of Grazing saved over A	—	24	24	62	71
Carcase Weight (DO% = 51) (kg)	220.58	220.58	220.58	220.58	220.58
Schedule Price ($/kg)	1.601 [a]	1.601 [a]	1.601 [a]	1.588 [b]	1.588 [b]
Gross Income ($/head)	353.14	353.14	353.14	350.28	350.28
Average Cost of Implant ($)	—	4.42	4.42	4.42	4.42
Lamb LWG foregone if feed limiting 1/1 to sale ($)	—	2.41	0.62	0.63	0.25
Lamb LWG gained from saved grazing ($)	—	19.21	19.21	49.63	56.83
Interest on Overdraft Avoided ($)	—	3.08	3.08	7.88	9.03
Income Net of Implant Effects ($)	353.14	368.60	370.49	402.74	411.41
Total Benefit over A ($)	—	15.46	17.25	49.59	58.33

a Weighted average schedule price for P1 steer, 220 245 kg carcase weight, net of buffer levy, for year ending 30 September 1983. Source: NZ Meat and Wool Boards' Economic Service.

b Weighted average schedule price for M bull, 220 245 kg carcase weight net of buffer levy, for year ending 30 September 1983. Source: NZ Meat and Wool Boards' Economic Service.

additional weight gain in lambs has been used to give the saved DM value, but other choices, clearly, are available to the farmer. It should nonetheless be emphasised that adding marginal value to existing livestock numbers is, at the numbers of lambs affected and rates of lamb LWG chosen for this study, likely to yield a greater profit than adding extra stock.

TABLE 4

STRATEGY TWO: Sale at Target Liveweight
Costs and Benefits for Implanted-Steer Options
LWG Response Rates Varied; Feed Conditions Constant

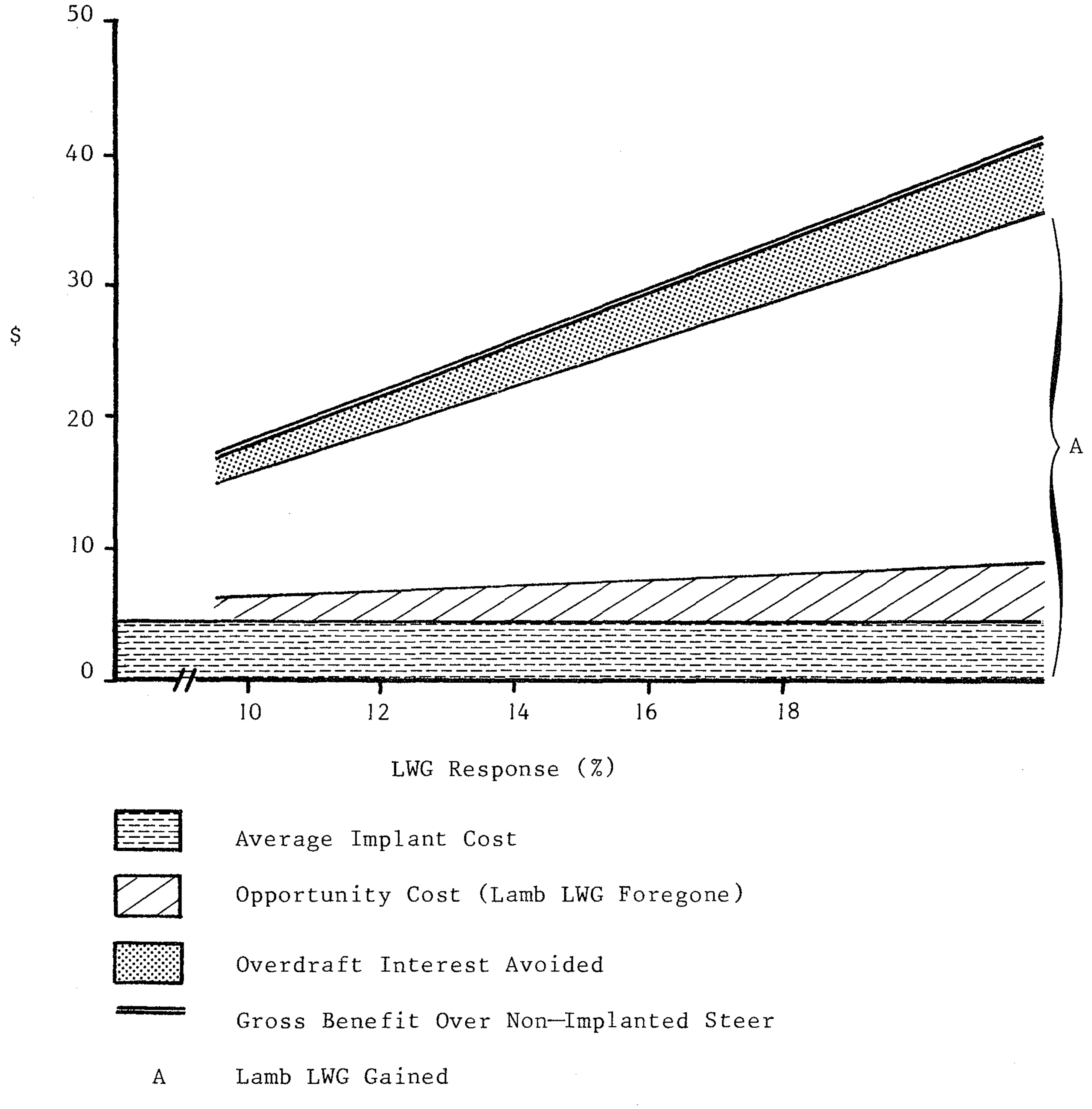
LWG Response Rate (%):	10	12	14	16	18
		OPTION B:			
Costs:	$	$	$	$	$
Implant	4.42	4.42	4.42	4.42	4.42
Lamb LWG foregone	2.02	2.41	3.18	3.37	3.58
Benefits:					
Additional Lamb LWG	15.21	19.21	22.41	25.61	28.81
Overdraft interest saved	2.44	3.08	3.59	4.10	4.61
Net Benefit due to Implant	11.21	15.46	18.40	21.92	25.42
		OPTION C:			
Costs:					
Implant	4.42	4.42	4.42	4.42	4.42
Lamb LWG foregone	0.12	0.62	1.48	1.81	2.10
Benefits:					
Additional Lamb LWG	15.21	19.21	22.41	25.61	28.81
Overdraft interest saved	2.44	3.08	3.59	4.10	4.61
Net Benefit due to Implant	13.11	17.25	20.10	23.48	26.90

4.4 Feed Availability

The two management strategies examined in this exercise have assumed conditions in which feed is limiting (i.e. monthly demand

FIGURE 3

STRATEGY 2, OPTION B: Changes in costs and benefits at various levels of LWG response



exceeding monthly growth so that decisions concerning feed involve a trade-off between livestock classes or conserved feed targets) for the period from 1 January to sale date only. To give an indication of the sensitivity of these analyses to differing conditions of feed availability, Tables 5 and 6 set out the net benefits of using GPAs at the 12 per cent LWG response rate, assuming that feed is limiting over a range of time periods. These data are represented graphically in Figure 4. Feed is assumed to be limiting either throughout the implant period, from 1 December, 1 January, 1 February, or not at all. Where feed is limiting before 1 January, pasture is assumed to be a mixed-length, leafy sward with higher metabolisable energy than late-summer pasture, and the conversion of difference in DDM to "lamb-equivalents" allows for this.

While all options generate positive net benefits over "A" under conditions of reasonable feed for both strategies, it can be seen in the Tables and Figure 4 that net benefits for the whole farm are fairly sensitive to changes in feed availability over time. This is particularly evident for Strategy 1; the benefits for steers in the most conservative option (option B) are reduced almost to zero as the proportion of the implant period in which feed is limiting increases. The benefits from the two implanted-steer options converge where feed is not limiting at all; at this point, the difference in opportunity cost generated by different FCE assumptions ceases to exist. The implanted-bull options show a continuous, near linear increase in benefits, with the slope increasing with the rate of LWG between D and E.

Under Strategy 2, feed limitations had less effect on profitability, as implanted animals were sold sooner than in Strategy 1. Option C is the most robust of all the options; it is apparent that implant-induced gains in FCE above those due to increased LWG minimise opportunity costs and therefore reduce the sensitivity of the option to changes in feed availability.

It must be emphasised that this analysis considers differences in profitability caused by changes in the DM available for lamb LWG only. At lower levels of nutrition, LWG response to implanting is often less; therefore, if implanted beef animals were not given priority in feed, a cost in terms of unrealised LWG response to implanting could also be incurred.

4.5 Return on Investment

The ratio of benefits to costs for both strategies was investigated, for all options at the 12 per cent LWG response rate, and for the implanted-steer options at a range of LWG responses. Figure 5 shows the costs and benefits in dollars for both strategies at the 12 per cent response rate, with the corresponding investment ratio at the top of each bar of the histogram. It is clear that Strategy 2 is the more profitable on-farm policy of the two, and that running implanted bulls as an alternative to steers could yield very large returns on investment following either strategy, whether or not schedule prices favour manufacturing bull beef over P1 steer.

TABLE 5

STRATEGY ONE: Benefits for All Implanted Options Under Various Feed Assumptions
12 per cent LWG response
($/implanted animal)

Period in which feed assumed limiting	OPTION: B ($)	C ($)	D ($)	E ($)
1/9 to 20/3 (200 days)	0.53	7.99	31.74	37.43
1/12 to 20/3 (110 days)	7.04	10.90	37.80	45.63
1/1 to 20/3 (79 days)	9.59	11.91	39.89	48.45
1/2 to 20/3 (48 days)	11.16	12.75	41.63	50.80
Not limiting at all	14.05	14.05	44.32	54.44

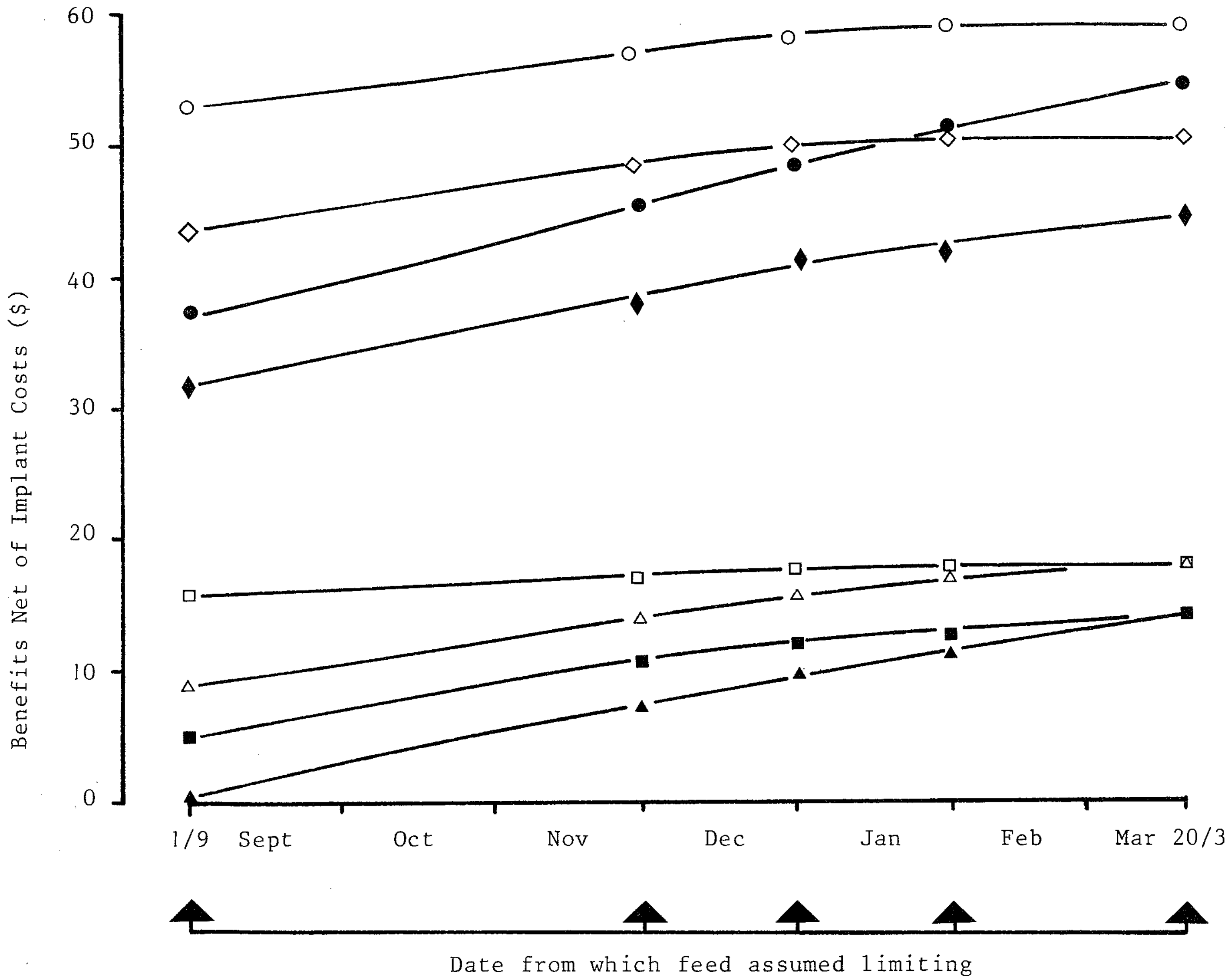
TABLE 6

STRATEGY TWO: Benefits for All Implanted Options Under Various Feed Assumptions
12 per cent LWG response
($/implanted animal)

Period in which feed assumed limiting	OPTION: B ($)	C ($)	D ($)	E ($)
From 1/9	8.97	15.59	43.85	53.05
From 1/12	13.80	16.82	48.12	56.98
From 1/1	15.46	17.25	49.59	58.33
From 1/2	16.84	17.61	50.23	58.58
Not limiting at all	17.87	17.87	50.23	58.58

FIGURE 4

Benefits for all implanted options
LWG response = 12 per cent
Feed availability varied



STRATEGY ONE

Steers:
▲ Option B
■ Option C

Bulls:
⧫ Option D
● Option E

STRATEGY TWO

Steers:
△ Option B
□ Option C

Bulls:
◇ Option D
○ Option E

FIGURE 5

Costs and Benefits at 12% LWG

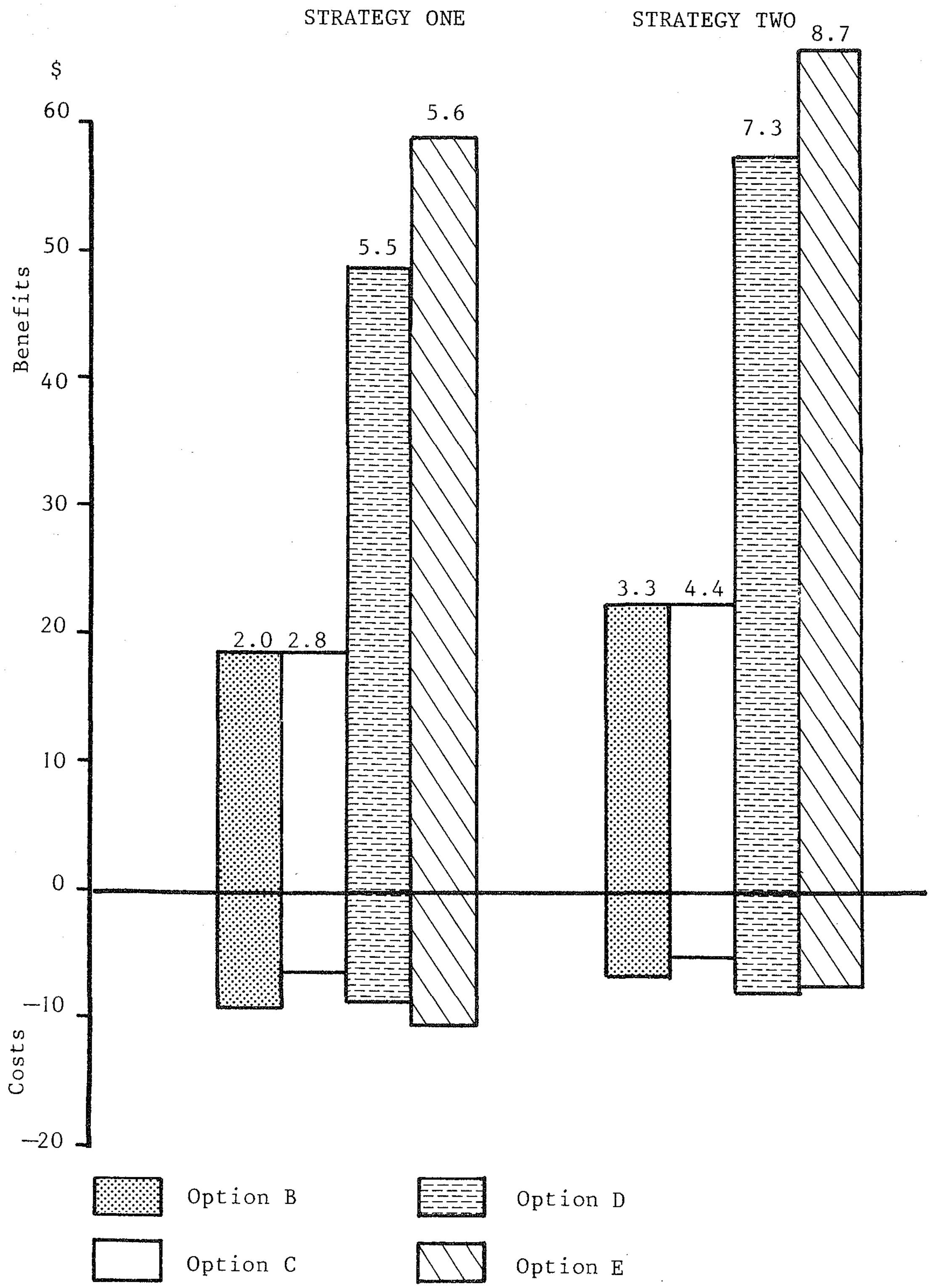


Figure 6, supported by data in Table 7, shows the extent to which the return on investment for the implanted-steer options changes with variations in the response rate. Under Strategy 1, the investment ratios increase steadily from 1.8:1 to 2.4:1 for option B, and from 2.7:1 to 3.1:1 for option C as the LWG response rate increases from 10 to 18 per cent. But under Strategy 2, the return on investment is not only higher than for Strategy 1 at all response rates, but also accelerates as the LWG response rate increases. Therefore implanting under Strategy 2 is not only a more profitable investment than under Strategy 1, but also one which is more responsive to higher rates of liveweight gain.

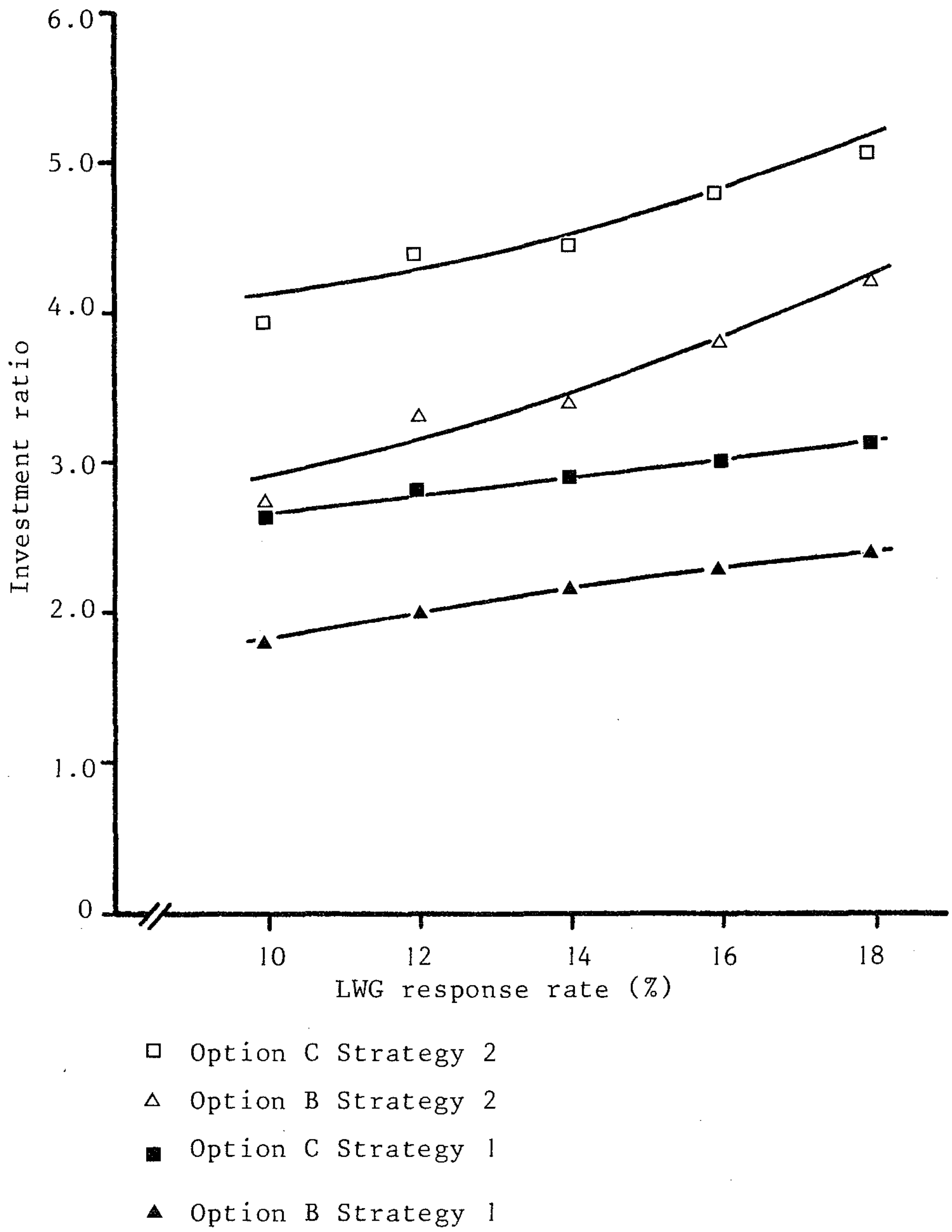
TABLE 7

Ratio of Benefits to Costs with Implanted Steers; LWG Response Varied

LWG Response Rate (%)	STRATEGY 1, OPTION: B	STRATEGY 1, OPTION: C	STRATEGY 2, OPTION: B	STRATEGY 2, OPTION: C
10	1.8	2.7	2.7	3.9
12	2.0	2.8	3.3	4.4
14	2.2	2.9	3.4	4.4
16	2.3	3.0	3.8	4.8
18	2.4	3.1	4.2	5.1

FIGURE 6

Ratio of Benefits to Costs with Implanted Steers: LWG Response Rate Varied



SECTION 5

CONCLUSIONS

The results and discussion presented in Section 4 of this paper have shown that measuring the profitability of growth-promoting agents used in a grass-based, mixed livestock farming system is somewhat more complex than the estimates based on carcase returns which have accompanied some trial results.

The theme of the paper has been that generating profits from GPAs - or from beef finishing as a whole - requires positive management, especially regarding the availability of feed. Several ideas are presented. Firstly, where a relatively fixed resource such as pasture is involved, a choice between uses carries an opportunity cost. Secondly, in order to maximise the potential response to a GPA, implanted animals require optimal feed conditions, which can have an impact on other farm enterprises when feed is limiting. Thirdly, rapid rates of LWG, whether achieved by feeding, implanting or both, generate better returns than lower rates of gain, even though opportunity costs are higher.

The partial feed budget used in this discussion therefore assumes that implanted beef animals will receive priority for feed. Following from this premise, the exercise has demonstrated that there is likely to be a measurable impact from use of GPAs, on the other livestock enterprises of a farm; the opportunity cost in this instance is valued using lamb LWG foregone as the measure. This cost can reduce the net benefit from implanting by nearly 50 per cent at lower rates of LWG, depending on the management strategy pursued.

At all stages of the analysis there has been a clear advantage to adopting a management policy of finishing beef animals to a target liveweight as quickly as possible, rather than to a planned sale date. This advantage is not dependent upon saved overhead and capital costs, but is considerably strengthened by their inclusion. Therefore, GPAs could prove a valuable management tool for achieving this goal. Even so, use of GPAs to achieve higher final liveweights at a planned sale date is still highly profitable by comparison with non-implanted outcomes.

The return to the farmer from an investment on growth-promoting agents in beef cattle needs only to exceed the total cost of its application to be worthwhile. The discussion in Section 4.5 makes it clear that, even under the less-advantageous management strategy and assuming a relatively modest LWG response, use of GPAs in steers can be a highly profitable on-farm investment.

It is also apparent that, if use of GPAs on bulls can modify behaviour sufficiently, there is potentially a large gain to be had from fattening bulls as an alternative to steers, particularly for strategies which take advantage of the higher rates of LWG to achieve target liveweights sooner, rather than larger carcases at sale date. Even under the most constraining assumption in Strategy 1, implanted bulls in option D yielded net benefits more than 3 times higher than implanted steers with assumed FCE improvement.

A part of this advantage is the liveweight difference of approximately 10 per cent in yearling animals, before implanting is carried out. Therefore, even if there was no difference in LWG between implanted bulls and implanted steers, the initial liveweight difference is preserved with a payoff of 10 kg carcase weight. For farmers whose properties are prone to drying off in summer, the advantages of being able to present larger animals at the beginning of the spring flush, and quit them before feed runs out, without the management limitations of running sexually active bulls, appear to be considerable.

This Discussion Paper is entirely theoretical in its approach, for want of field-generated data regarding DM intake and FCE in implanted animals on pasture. The significance of opportunity costs at lower rates of LWG response, particularly when finishing to a planned sale date, suggests that there is a need to confirm whether or not these costs have a material effect on the profitability of GPAs in practice. The author would welcome such a study.

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APPENDICES

APPENDIX 1

Daily LWG and DM Requirements at 12 per cent LWG Response Rate

	Start weight (kg)	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
OPTION A	200												
Daily LWG (kg)		0.47	0.34	0.45	0.45	0.46	0.75	0.92	1.01	0.97	0.77	0.63	0.77
Daily DM (kg)		4.4	4.2	4.6	4.8	5.0	6.3	7.3	8.2	8.5	7.6	7.5	8.5
OPTION B	200												
Daily LWG (kg)		0.47	0.34	0.45	0.45	0.46	0.84	1.03	1.13	1.09	0.78	0.71	0.86
Daily DM (kg)		4.4	4.2	4.6	4.8	5.0	6.6	7.8	8.8	9.2	9.2	8.1	9.2
OPTION C	200												
Daily LWG (kg)		0.47	0.34	0.45	0.45	0.46	0.84	1.03	1.13	1.09	0.78	0.71	0.86
Daily DM (kg)		4.4	4.2	4.6	4.8	5.0	6.4	7.5	8.4	8.8	7.9	7.8	8.9
OPTION D	220												
Daily LWG (kg)		0.53	0.38	0.50	0.50	0.52	0.84	1.03	1.13	1.09	0.78	0.71	0.86
Daily DM (kg)		4.4	4.2	4.6	4.8	5.0	6.2	7.3	8.2	8.6	7.7	7.6	8.6
OPTION E	220												
Daily LWG (kg)		0.53	0.38	0.50	0.50	0.52	0.88	1.11	1.19	1.14	0.82	0.75	0.90
Daily DM (kg)		4.4	4.2	4.6	4.8	5.0	6.7	8.0	9.0	9.4	8.3	8.3	9.3

APPENDIX 2

Calculation of Opportunity Cost - Value of Lamb Liveweight Gain

Up to 31 December a reduction in daily DM allowance of 0.5 kg is considered to reduce lamb LWG by 100 g/day/lamb, from 200 to 100 g daily LWG. After this date, pasture is assumed to be drier and stalkier than the mixed leafy sward of spring and early summer. Data presented in the MAF publication "Feed Budgeting" indicate that to achieve the same level of metabolisable energy as in the mixed-length sward, DM requirements for late summer should be adjusted upwards by approximately 20 per cent. Therefore the change in DM required to affect weight gain by 100 g/lamb/day is increased to 0.6 kg/day from 1 January onwards.

The conversion of DM to dollars assumes that lambs will be dressed out cold at 42 per cent of liveweight, valued at the schedule price for PM lamb in March 1983 of $1.485/kg.

An example from Table 1 is given:

Difference in av. daily DM; B over A (kg)	:	0.58
Change in DDM required to reduce LWG by 100g/lamb/day (kg)	:	0.6
Number of "lamb equivalents" with LWG reduced by 100g/day	:	0.97
Number of days when feed is limiting (1/1 to 20/3)	:	79
Total liveweight reduction over 79 days (kg)	:	7.64
Total carcase weight reduction (kg)	:	3.21
Schedule price ($/kg)	:	1.485
Value of lamb LWG foregone ($)	:	4.76

APPENDIX 3

Weighted Average Schedule Prices for Various Beef Grades

(cents per kilogram, September years)

	Manufacturing Cow	P1 Steer	Bull	All Beef
1975-76	44.6	58.1	55.9	51.9
1976-77	48.0	62.4	66.6	56.5
1977-78	56.3	67.4	70.3	61.7
1978-79	110.9	114.3	123.5	112.9
1979-80	108.2	126.7	135.1	120.0
1980-81	106.8	124.4	122.1	117.8
1981-82	124.9	143.6	143.0	136.0
1982-83	136.0	164.2	158.8	153.1

Source: Meat and Wool Boards' Economic Service

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